

AD A030738

UNITED STATES ARMY AVIATION BOARD
Fort Rucker, Alabama

ATBG-DT-AVN-3468

11/27 MAY 1960

SUBJECT: Report of Evaluation of the McDonnell Model 120 Flying Crane

TO: Commanding General
United States Continental Army Command
Fort Monroe, Virginia
ATTN: ATDEV

I. AUTHORITY. Letter, CRD/H 9072, Office of the Chief of Research and Development, Department of the Army, 21 July 1959, subject: "Navy Evaluation of the McDonnell Model 120 Flying Crane," with 1st Ind, ATDEV-6 452.1 (21 Jul 59), Headquarters, USCOMARC, 27 July 1959.

II. PURPOSE. To observe and participate in the Navy evaluation of the McDonnell Model 120 Flying Crane to determine the potential of this helicopter for Army use.

III. SCOPE. The McDonnell Model 120 Flying Crane was flown for 2.8 flight hours on 1 December 1959 at Smartt Field, St. Louis, Missouri, by US Army Aviation Board personnel. Maneuvers performed included takeoffs to a hover, hovering flight, sideward and rearward flights, takeoffs from a hover, climbs, descents, 360-degree pedal turns, running landings, landing from a hover, autorotations with power recoveries, and the transporting of external loads.

IV. GENERAL INFORMATION.

1. Background. The McDonnell Aircraft Corporation, Lambert Field, St. Louis, Missouri, developed the McDonnell Model 120 Flying Crane as an experimental vehicle utilizing the dynamic rotor components developed in the XV-1 program. The US Navy Bureau of Aeronautics (Bureau of Weapons) conducted a 50-hour evaluation of this flying crane during the period October - November 1959 and informally invited Army participation. As a result, Board personnel reviewed the crane in detail with McDonnell personnel at McDonnell Aircraft Corporation on 1-2 December 1959.

2. Description of Materiel.

a. The McDonnell Model 120 Flying Crane is a single-place, three-bladed single-rotor crane, powered by pressure jets at the rotor blade tips. The three turbine engines operate independently, thereby providing multi-engine capability.

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(1) Compressed air is supplied to the plenum chamber at the rotor hub by bleeding air from the compressor stages of three AiResearch GTC-85-135 gas turbine engines mounted side by side and aft of the rotor centerline. In the plenum chamber the compressed air is divided and flows through the blade air ducts to the tip mounted pressure jet burners where fuel is injected and the mixture is burned. The hot combustion gases exit through convergent exhaust nozzles, producing reaction power forces and rotor driving torque, thus eliminating the need for a transmission.

(2) The Model 120 has conventional flight controls with the exception that the conventional motorcycle grip synchronized throttle on the collective pitch control has been replaced with a five-position twist grip called the engine bleed control. Each of the five positions available on the twist grip is an indication of the pilot-selected power available. Water injection to the turbines is also available to increase power. Directional control is attained by deflection of rudder surfaces and gas turbine exhaust vanes by pilot activation of standard directional control pedals.

(3) The Model 120 is characterized by a simple and rugged construction throughout and is designed to assure ready access to any component for maintenance and quick engine change (manufacturer states that engines can be removed in 20 minutes). The rigid rotor system requires no tracking or rigging; however, it cannot be folded.

b. Dimensions, weight, and performance data for the Model 120 Helicopter, as reported by the manufacturer, are as follows:

Aircraft height - 9 feet 0 inches		
Tread of skids - 9 feet 2 inches		
Rotor diameter - 31 feet 0 inches		
Gross weight (pounds)	5,000 (Design gross weight*)	6,300 (Maximum gross weight**)
Empty weight (pounds)	2,450	2,450
Useful load (pounds)	2,550	3,850
Maximum speed (knots)	120	120
Maximum rate of climb, sea level (feet per minute)	2,400	1,400
Hovering ceiling, out of ground effect:		
NACA standard conditions (feet)	10,000	1,700
95°F. at altitude (feet)	6,000	--
Vertical rate of climb, sea level (feet per minute)	1,500	300

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Maximum endurance, sea level

60 knots (hours)	1.21	1.0
Range (nautical miles)	85	80
Fuel capacity (gallons) JP-4	212	212

*Gross weight for 700 f.p.m. sea level maximum rate of climb with one engine inoperative.

**Gross weight for 100 f.p.m. sea level maximum rate of climb with one engine inoperative.

V. TESTS.

1. General Characteristics.

a. Cockpit Arrangement. The Model 120 Flying Crane cockpit design was a concept with which most helicopter pilots are unfamiliar in that it was a single-place configuration. The pilot's seat was located below and forward of the turbines and provided excellent all-around horizontal and vertical visibility. Cockpit access was afforded by an entrance door from either the right or left, the skid cross tube facilitated easy entrance from the ground. The five detents provided on the throttle twist were OFF, single-, two-, three-engine bleed and military power (water injection). A rotor tip fuel on-off control was located above and to the left of the pilot's head level. A pressure tip burner ignition switch was located on the collective control and forward of the twist grip. A rotor hub brake was located on the collective control and well to the rear of the twist grip. To preclude inadvertent application of the rotor hub brake, the pilot was required to move his hand from the twist grip at any time the hub brake was required.

b. Instrument Arrangement. The instrument panel location of the Model 120 was low and tilted at an angle so as to allow good readability and maximum visibility. Instrumentation appeared to be adequate. Instruments, switches, and warning lights, other than those normally required for helicopter operations, provided were:

- (1) Rotor hub pressure gauge.
- (2) Hub lubrication low-pressure warning lights.
- (3) Engine start switches in sequence with corresponding:
 - (a) Generator warning lights.
 - (b) Engine oil pressure warning lights.
 - (c) Engine bleed air warning lights.

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- (4) Water injection switch.
- (5) Tip jet ignition switch.
- (6) Rotor tip fuel on-off control.

2. Operating Characteristics. The operating characteristics of the Model L20 were evaluated while performing normal flight maneuvers.

a. Engine Starting Rotor Engagement and Takeoff. Engine starting, rotor engagement, and takeoff could easily be accomplished in 60 seconds. All starts were made on the aircraft battery. Ease and reliability of starts as noted during this evaluation would be ideal for rapid takeoffs in emergency rescue or for fire-fighting missions. Takeoffs could have been made within 35 seconds by using a shorter starting sequence (see (2) below). This shorter sequence would have required collective movement to prevent rotor overspeed and would have required a greater load on the battery but would be feasible for emergency takeoffs. There was no wind restriction governing rotor engagement on the rigid rotor system employed in the Model L20.

(1) The significant items of the normal starting procedure were as follows:

(a) Cockpit check to include:

- 1. Fuel level (visual).
- 2. Master power ON.
- 3. Main fuel ON.
- 4. Rotor hub brake on.
- 5. Engine twist grip in zero engine bleed.

(b) Actuate No. 1 engine switch to start. When temperature of tailpipe rises, and generator light goes out, actuate No. 2 engine to start, then No. 3 engine to start.

(c) Open twist grip No. 2 engine bleed. Release rotor hub brake and as rotor reaches 50 r.p.m. open rotor tip fuel valve and ignite tip burners.

(d) Safe takeoffs require rotor speed stabilization in the operating range (415-450 r.p.m.).

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(2) The shorter starting sequence included the cockpit checks (as in (1) (a) above) of the normal starting procedure. Then No. 1, No. 2, and No. 3 engine switches were actuated simultaneously. When the desired tail pipe temperatures were reached, and after the generator lights went out, the rotor hub brake was released and the rotor tip fuel valves opened, thus igniting the tip burners. During this starting procedure, the twist grip control was in No. 3 engine bleed and required upward movement of the collective pitch to prevent rotor overspeed due to rapid acceleration.

b. Flight Characteristics.

(1) Aircraft control during flight was smooth and positive through most regimes of flight; during hovering flight, however, lateral cyclic control was sensitive when compared to longitudinal cyclic control. This was attributed to the fact that the control linkage provides greater response laterally than longitudinally for any given amount of cyclic stick displacement. Response to the collective control was superior to that of most helicopters. Directional control was less positive than in tail-rotor configurations but was superior to other helicopters using exhaust deflections or to synchropters. During climbs, level flight and descents, a certain amount of lateral cyclic stick displacement was required; however, this could be corrected by minor control linkage redesign.

(2) All-around horizontal and vertical visibility was excellent during flight. During sling load operations the pilot could visually monitor the hookups, the load in flight, and the releases.

(3) The Model 120 is capable of operation with only two of its gas turbine engines functioning.

(4) The blade tip pressure jets emit a characteristic halo effect not visible from the cockpit in daylight. It was assumed that this might hinder night operation; however, this halo effect was not evaluated because the flying crane was not equipped for night flying.

(5) Vertical climbs at a rate of more than 2000 f.p.m. were made at a takeoff weight of 3900 pounds.

c. Vibration and Noise Level. Vibration in the Model 120 appeared to be low. This was attributed to the rotor design, the absence of transmission and tail rotor components, and the fact that the rigid rotor system cannot develop an out-of-track condition. The noise level and frequency in the cockpit during all operations were acceptable; to personnel on the ground, however, the noise level and frequency were uncomfortable. Maintenance personnel should be provided with ear-cover sound suppressors when working near the Model 120.

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d. Pilot Transition Training. It appears that transition to the Model 120 for experienced helicopter pilots could be readily accomplished.

VI. DISCUSSION.

1. The Model 120 design is unusually simple and rugged. All components are within the 31-foot rotor diameter. The crane is easy to fly, offers multi-engine safety, has a minimum of vibration, has excellent visibility, has no ground resonance tendencies, has good high-wind hover stability, will lift a payload of slightly more than its own weight, and offers single-point suspension for sling loads. The noise level and frequencies under certain conditions and the anticipated halo effect under blackout conditions are unacceptable. A minimum of maintenance requirements would be necessary due to accessibility, lack of a tail rotor, quick engine change, and the rigid rotor system which requires no tracking.

2. In the design of the Model 120, available power that is required for extended operation in the "dead man's curve" is provided, (reference 3, Project Nr AVN 1860). Consideration has been given to providing maximum safety for personnel and aircraft during extended flight in the high hovering and low-air-speed caution areas.

3. While the Model 120 has an impressive useful-load-to-empty-weight ratio, either the H-21 or H-34 (or, for a mission of its own design radius, the HU-1) can lift heavier loads.

VII. CONCLUSION.

1. The Model 120 does not meet existing Army requirements.

2. The McDonnell Model 120 concept, built to a larger size, shows promise for fulfilling the 12-ton flying crane requirement (CDOG subparagraph number 533a(14)).

VIII. RECOMMENDATION. It is recommended that the Army monitor the Navy heavy lift (flying crane) program which uses the McDonnell Model 120 propulsion concept.

IX. REFERENCES.

1. Letter, ATBG-DGAC, US Army Aviation Board, 18 December 1959, subject: "Evaluation of McDonnell Model 120 Flying Crane," with 1st Indorsement.

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2. Project TED No. PTR AC-42101.1, Navy Evaluation of Model 120 Helicopter, Report No. 1, Final Report, Naval Air Test Center, 22 December 1959.

3. Report of Test, Project Nr AVN 1860, "Evaluation of the S-60 Crane Concept," US Army Aviation Board, 30 December 1959.


FOR JACK L. MARINELLI
Colonel, Artillery
President